

**TRANSMITTING DATA FRAMES WITH  
LESS INTER FRAME SPACE (IFS) TIME**

This application claims priority to US Provisional Applications Serial Nos.

5 60/478,156 filed on June 12, 2003, and 60/487,694 filed on July 16, 2003, the entire disclosures of which are hereby incorporated by reference.

The present invention relates to data network transmission techniques, and in particular, to an optimized method for more efficiently transmitting data frames, in which the data frames are transmitted over a data network with less Inter Frame Space (IFS) time.

10 In data transmission, an ARQ (Automatic Retransmission Request) protocol specifies that each frame has to be acknowledged by the receiver with an ACK (Acknowledge) frame. This, however, reduces the efficiency of data transmission since the transmitter has to wait for receiving the ACK before it can send a next data frame. This is also true in a wireless data network using IEEE 802.11 protocol for MAC data frames  
15 transmission. To improve the efficiency, IEEE 802.11e defines a No ACK policy in which the frames are not acknowledged, and a Block ACK policy in which the frames are acknowledged in groups with a single Block ACK frame. These new policies considerably reduce the frame overhead and increase the efficiency.

Moreover, IEEE 802.11e has introduced the concept of transmission opportunity  
20 (TXOP). By this concept, the non-AP QSTA (non access point QoS enhanced station) and QAP (QoS enhanced access point) contend the medium for time, and once they get access to the channel they can hold the channel for the time specified by TXOPlimit and transmit multiple data frames with an inter frame space (IFS) time which is SIFS (Short IFS). IEEE 802.11e specifies that during a TXOPlimit, a non-AP QSTA/QAP may use the No ACK or  
25 Block ACK policy. By No ACK, each frame is transmitted and the ACK is not expected for that frame. If the TXOPlimit were larger than the single frame transmission time and if

more frames are pending transmission at the MAC queue, the succeeding frames may be transmitted after SIFS time. Similarly, in the Block ACK policy, frames are transmitted successively with an inter frame space time SIFS before the transmission of the ACKs by the receiver.

5           This is, however, not optimized in terms of transmission efficiency since SIFS time is actually required only if the receiving non-AP OSTA/QAP were to return an acknowledgement as it includes the time to process the frame plus the receiver (RX) to transmitter (TX) turnaround time. In case of No ACK as well as Block ACK policies, it is not necessary to have the receiver wait for the SIFS time to transmit the ACK frame  
10 (except for the last frame in the block ACK policy after which the receiver must send an ACK to the transmitter).

Therefore, there is a need in the art for a method to more efficiently transmit data frames in a data network with less inter frame space (IFS) time.

According to the present invention, a method of transmitting data frames over a  
15 data network is provided, which comprises a step of sending the data frames from a transmitter to a receiver with an Inter Frame Space (IFS) time. In particular, the IFS does not include a time that the transmitter needs to change from a receiver state to a transmitter state. Preferably, the IFS only includes a time needed for the transmitter to detect ending of a frame and beginning of a next frame. Thus, the transmitter may transmit the data frames  
20 continuously with an IFS shorter than SIFS since it does not include the turnaround time.

The above and further features and advantages of the present invention will be clearer by reading the detailed description of preferred embodiment of the present invention, with reference to the accompanying drawings in which:

25           Figure 1 illustrates transmission of data frames with IFS between frames; and

Figure 2 illustrates that IFS is SIFS as required in the prior art.

As illustrated in Figure 1, a data frame typically includes a physical layer control procedure (PLCP) overhead and a MAC data frame. The PLCP overhead comprises a PLCP preamble 11 and a PLCP header 12. The PLCP preamble 11 includes information  
5 mainly used for timing and synchronization functions and the PLCP header 12 mainly includes information about the length of the frame, the transmission rate, etc. The MAC data frame comprises a MAC header 21 portion including address information, etc., a MAC frame body portion 22 and a CRC (Cyclic Redundancy Check) portion 23, which is known as Frame Control Sequence (FCS) in the MAC layer.

10 When a transmitter continuously transmits sequential data frames to a receiver, an inter frame space (IFS) time is required between transmission of two sequential frames. Conventionally, this IFS time may be as short as SIFS (Short IFS) under No ACK and Block ACK policies adopted by IEEE 802.11e. As shown in Figure 2, SIFS includes a first portion of time T1 required for the transmitter to process a data frame, i.e., to detect the  
15 end of a frame and the start of a next frame, as well as a second portion of time T2, i.e., the "turnaround time" for the transmitter to change from a receiver state to a transmitter state. The SIFS time is a waste under No ACK and Block ACK policies as the transmitter does not need to receive the ACK from the receiver before it can continue to send the next data frame.

20 According to the present invention, under No ACK and Block ACK policies, the transmitter does not need to wait for SIFS to send a next data frame. In particular, frames that do not need an ACK immediately are transmitted continuously with an IFS which can be much shorter than SIFS. More specifically, the IFS time does not need to include the turnaround time T2 which otherwise is needed for the transmitter to change from the  
25 receiver state to the transmitter state, and only includes a time T1 needed for the transmitter

to process the frame, i.e., to detect the end of the frame, and the beginning of the next frame. Therefore, data frames can be transmitted with an inter frame space much less than SIFS, thus considerably increasing the transmission efficiency.

Though the above has described the preferred embodiment of the present invention  
5 in detail, it shall be appreciated that, without departing the spirit of the present invention, various changes, adaptations and amendments are possible to a skilled person in the art. For example, though the preferred embodiment is described in a wireless data network using IEEE 802.11 protocol amended by IEEE 802.11e draft standard, it is understood that the present invention is not limited to a wireless data network environment. Thus, the  
10 protection scope of the present invention is intended to be solely defined in the accompanying claims.